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DATE: July 18, 2002

SUBJECT: EXPOSURES TO 1,3-DICHLOROPROPENE IN KERN COUNTY BASED ON THE FALL 2001 MONITORING BY THE CALIFORNIA AIR RESOURCES BOARD

This memorandum gives inhalation exposures as average concentrations of 1,3-dichloropropene (1,3-D) in air for 24-hour, 1-week and 9-week averaging periods, based on monitoring done by the California Air Resources Board in Kern County in Summer 2001 (ARB, 2002).

Methods

Following the practice of the Worker Health and Safety (WHS) Branch, this memorandum reports arithmetic mean concentrations and tolerance limits estimated using lognormal methods. Lognormality is assumed for environmental contaminants in most cases. DPR's experience with many large environmental datasets has shown that they are usually well described by the lognormal distribution. In addition, WHS prefers to avoid the inconsistency of using different exposure statistics based on sample characteristics. WHS uses the arithmetic mean concentration because the concentration of interest for exposure assessment is the overall concentration in all of the air that a person could breathe during the averaging period. The arithmetic mean concentration is the best estimate of the average mass of residue per unit of environmental medium; it is equivalent to compositing all of the samples and measuring the concentration of the mixture (Parkhurst, 1998). This is true regardless of the shape of the underlying distribution.

Of 240 samples, 48 were below the limits of detection for both cis-1,3-D (LOD = 0.002 ppbv) and trans-1,3-D (LOD = 0.003 ppbv); 120 samples contained quantifiable amounts of both cis- and trans-1,3-D (the limits of quantitation (LOQ) were 0.010 and 0.014 ppbv, respectively). Before cis- and trans- concentrations were summed to get total 1,3-D for each sample, one-half the LOD was substituted for an isomer below the LOD, and one-half the LOQ was substituted for an isomer below the LOQ.

Forty-six samples with flow-rate deviations greater than 25% were excluded from the analysis. Where there were two samples taken at a site on the same day, the arithmetic mean of the two values was used. In three cases, a site had a usable sample for only one day in the week. One site had no data for the first week of monitoring. The data were not adjusted for recovery (average 80% in 8 laboratory spikes, 86% in 8 trip spikes and 77% in 8 field spikes).

24-hr exposure

For each monitoring-site separately, the maximum observed and the 95% tolerance limit for 24-hr concentrations are given. The 95% tolerance limit is the concentration that, with given probability, will be exceeded in 5% of future samples (Hahn and Meeker, 1991). It is calculated using lognormal distribution methods:

$$95\%\ \text{tolerance limit} = \exp\{\text{arithmetic mean of log concentrations} + g_{(.90;.95;\,n)} * (\text{sd of logs})\}.$$

The multiplier g for 90% probability is tabled in Hahn and Meeker (1991).

1-week exposure

For each monitoring site separately, the maximum and the 95% tolerance limit for weekly mean concentrations are given. Each weekly mean is calculated as the arithmetic mean of the 24-hr samples taken at a site during the week (i.e., nonmonitoring days are ignored). The 95% tolerance limit for weekly mean concentrations is calculated using normal distribution methods:

$$95\%\ \text{tolerance limit} = \text{arithmetic mean of week means} + g_{(.90;.95;\,n)} * (\text{sd of week means}).$$

Normal methods are used in this case because sample means from any distribution tend to be normally distributed.

9-week exposure

For each monitoring site separately, average exposure over the 9-week monitoring period is calculated as the arithmetic mean of the weekly means (calculated as above for 1-week exposure).

Results

Twenty-four-hour, 1-week and 9-week concentrations are presented in Table 1. Daily concentrations and intermediate calculations are shown in Table 2.

Table 1. 1,3-dichloropropene concentrations (ppbv) in Kern County, 30 June – 30 August 2001, based on monitoring by the California Air Resources Board.

		Daily		1-week		9-week
Site [a]	N days	Maximum 24-hr	95% tolerance limit	Maximum weekly [b] mean	95% tolerance limit	Mean of weekly means
		ppbv				
ARB	32	0.151	0.276	0.070	0.094	0.035
ARV	25	21.1	4.40	8.33	8.29	0.991
CRS	31	0.604	0.220	0.175	0.181	0.036
MET	29	3.00	1.06	1.26	1.26	0.175
MVS	26	1.64	2.01	0.552	0.709	0.188
VSD	27	7.95	3.34	2.36	2.62	0.443

a Monitoring sites described in ARB (2002).
b Each weekly mean is the arithmetic mean of the 24-hr samples (*n* ranged 1-4) in a calendar week.

Exposure appraisal

The average concentrations presented here are based on limited monitoring data and must be considered as having some degree of uncertainty. The representativeness of the six monitoring sites is unknown. Each site was monitored 1 - 4 days per week for a relatively short (9-week) period. Weekend days were not monitored. It is unknown whether weekdays and weekends differ systematically in numbers of 1,3-D fumigations.

References

ARB. 2002. Ambient air monitoring for methyl bromide and 1,3-dichloropropene in Kern County - Summer 2001. Final report dated June 18, Project No. P-01-004. Sacramento, CA: Quality Management Branch, Monitoring and Laboratory Division, Air Resources Board, California Environmental Protection Agency.

Hahn, G.J., and Meeker, W.Q. 1991. *Statistical Intervals: A Guide for Practitioners*. New York, John Wiley & Sons, Inc.

Parkhurst, D.F. 1998. Arithmetic versus geometric means for environmental concentration data. *Environmental Science and Technology News.* Feb. 1.

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Table 2. Daily concentrations and intermediate calculations for Kern County sites.

Date	Week	ARB	ARV	CRS	MET	MVS	VSD	ARB	ARV	CRS	MET	MVS	VSD
		ppbv						ln(ppbv)					
30-Jun-01	1	0.0024	0.0024	0.0024				-6.04	-6.04	-6.04			
1-Jul-01	1	0.0024		0.0024	0.0024	0.0024		-6.04		-6.04	-6.04	-6.04	
2-Jul-01	1	0.0024		0.0024	0.0024			-6.04		-6.04	-6.04		
	1 Average	0.0024	0.0024	0.0024	0.0024	0.0024							
6-Jul-01	2	0.0119	0.0183	0.0119	0.0119			-4.43	-4.00	-4.43	-4.43		
7-Jul-01	2	0.0063	21.1112	0.0024	0.0197		0.3104	-5.07	3.05	-6.04	-3.93		-1.17
8-Jul-01	2	0.0071	3.8691	0.0024	0.0119	0.4199	0.3427	-4.94	1.35	-6.04	-4.43	-0.87	-1.07
	2 Average	0.0084	8.3328	0.0056	0.0145	0.4199	0.3265						
13-Jul-01	3	0.0401	0.0729	0.0306	0.1321		0.0246	-3.22	-2.62	-3.49	-2.02		-3.70
14-Jul-01	3	0.0300		0.0119			0.1578	-3.51		-4.43			-1.85
15-Jul-01	3	0.0119	0.3170	0.0071	0.0119	0.0763	0.0457	-4.43	-1.15	-4.94	-4.43	-2.57	-3.08
16-Jul-01	3	0.0024	0.4554		0.0119	0.1329	0.1043	-6.04	-0.79		-4.43	-2.02	-2.26
	3 Average	0.0211	0.2817	0.0165	0.0520	0.1046	0.0831						
21-Jul-01	4	0.0406	0.1611	0.0119	0.0119	0.4647	1.3563	-3.20	-1.83	-4.43	-4.43	-0.77	0.30
22-Jul-01	4	0.0904	0.0622	0.0304	0.0119	0.0885	0.1164	-2.40	-2.78	-3.49	-4.43	-2.43	-2.15
23-Jul-01	4	0.0119		0.0119		0.0119	0.0296	-4.43		-4.43		-4.43	-3.52
24-Jul-01	4	0.0119	0.0902	0.0024	0.0119	1.6440	7.9460	-4.43	-2.41	-6.04	-4.43	0.50	2.07
	4 Average	0.0387	0.1045	0.0141	0.0119	0.5523	2.3621						
29-Jul-01	5	0.0119	0.0674	0.0119	0.0119	0.1955	0.2885	-4.43	-2.70	-4.43	-4.43	-1.63	-1.24
30-Jul-01	5	0.0024	0.0946	0.0024	0.2619	0.0119	0.0119	-6.04	-2.36	-6.04	-1.34	-4.43	-4.43
31-Jul-01	5	0.0715	0.1108	0.0024	0.3387	0.7107	1.5431	-2.64	-2.20	-6.04	-1.08	-0.34	0.43
1-Aug-01	5	0.1510	0.0533	0.0024	0.0391	0.1845	0.0696	-1.89	-2.93	-6.04	-3.24	-1.69	-2.67
	5 Average	0.0592	0.0815	0.0048	0.1629	0.2757	0.4783						
6-Aug-01	6	0.0119	0.0812	0.0024	0.0024	0.0357	0.0119	-4.43	-2.51	-6.04	-6.04	-3.33	-4.43
7-Aug-01	6	0.0119		0.0024	0.1641	0.0202		-4.43		-6.04	-1.81	-3.90	
8-Aug-01	6	0.0308	0.0978	0.6043	1.8843		0.1723	-3.48	-2.32	-0.50	0.63		-1.76
9-Aug-01	6	0.1119	0.0505	0.0896	2.9962	0.0793	0.0916	-2.19	-2.99	-2.41	1.10	-2.53	-2.39
	6 Average	0.0416	0.0765	0.1747	1.2618	0.0451	0.0919						

continued

Table 2. Continued.

Date	Week	ARB	ARV	CRS	MET	MVS	VSD	ARB	ARV	CRS	MET	MVS	VSD
		ppbv						ln(ppbv)					
14-Aug-01	7	0.0024	0.0071	0.0024	0.0713	0.0119	0.0119	-6.04	-4.94	-6.04	-2.64	-4.43	-4.43
15-Aug-01	7	0.1052		0.0409	0.0633	0.5177	0.2422	-2.25		-3.20	-2.76	-0.66	-1.42
16-Aug-01	7	0.1026			0.0119	0.2013	0.3661	-2.28			-4.43	-1.60	-1.00
17-Aug-01	7		0.0119	0.0119	0.0256	0.2107	0.0119		-4.43	-4.43	-3.66	-1.56	-4.43
	7 Average	0.0701	0.0095	0.0184	0.0430	0.2354	0.1580						
22-Aug-01	8	0.0564	0.0119	0.0024	0.0119	0.0306	0.0119	-2.87	-4.43	-6.04	-4.43	-3.49	-4.43
23-Aug-01	8	0.0294	0.0024	0.0024	0.0119	0.0119	0.0119	-3.53	-6.04	-6.04	-4.43	-4.43	-4.43
24-Aug-01	8	0.0418	0.0285	0.0476	0.0190	0.0191	0.0169	-3.17	-3.56	-3.04	-3.96	-3.96	-4.08
25-Aug-01	8	0.0492	0.0187	0.0622	0.0177	0.0119	0.0119	-3.01	-3.98	-2.78	-4.03	-4.43	-4.43
	8 Average	0.0442	0.0153	0.0287	0.0151	0.0184	0.0131						
28-Aug-01	9	0.0430		0.0182		0.0119		-3.15		-4.01		-4.43	
29-Aug-01	9	0.0324	0.0197	0.1244	0.0119	0.0350	0.0516	-3.43	-3.93	-2.08	-4.43	-3.35	-2.96
30-Aug-01	9	0.0119	0.0119	0.0300	0.0119	0.0780	0.0119	-4.43	-4.43	-3.51	-4.43	-2.55	-4.43
	9 Average	0.0291	0.0158	0.0575	0.0119	0.0416	0.0317						
SUMMARY													
Mean of week means		**0.035**	**0.991**	**0.036**	**0.175**	**0.188**	**0.443**	-4.00	-2.84	-4.67	-3.60	-2.75	-2.55
SD of week means		0.022	2.755	0.055	0.410	0.196	0.792	1.30	2.03	1.51	1.75	1.62	1.78
Max of week means		**0.070**	**8.333**	**0.175**	**1.262**	**0.552**	**2.362**	32	25	31	29	26	27
n weeks		9	9	9	9	9	8						
95th %ile of week means		0.08	6.11	0.14	0.94	0.55	1.94						
90% tol limit on 95th%		**0.094**	**8.291**	**0.181**	**1.263**	**0.709**	**2.623**	95th %ile of days (ppbv)					
								0.167	1.875	0.123	0.539	1.028	1.628
Max of days		**0.151**	**21.111**	**0.604**	**2.996**	**1.644**	**7.946**	**0.276**	**4.401**	**0.220**	**1.064**	**2.006**	**3.342**
								90% tol limit on 95th%ile of days (ppbv)					